

Remarks

Claims 1, 3, 5, 6, 13 and 17-29 are pending in the application. The claims have been rejected as allegedly obvious over King, either alone or in combination with "admitted art" disclosed in the background section of the specification. This application and the individual teachings of King will be discussed first. The relevance of the "admitted art", the combined teaching of the references and the propriety of making the theoretical combination will be discussed below.

This Application vs. King

This invention relates to a two step process in which a crude starting material is ultimately converted into useful C7 or C8 aromatic hydrocarbons. The first step is distillation of the crude starting material to obtain a material having a very low non-aromatic compound content, which is reacted in the second step to obtain the useful C7 or C8 aromatic hydrocarbons. Performance of the first step is based on the critical discovery that the reaction of a material having a very low non-aromatic compound content, in the presence of hydrogen and a catalyst containing mordenite and about 0.02 to 2% by weight rhenium (the second step - to diminish the benzene content and convert at least a portion of the material into useful C7 or C8 aromatic hydrocarbons), consumes a surprising low amount of hydrogen and results in a surprising long catalytic life. In fact, the two-step process utilizes over 25% less hydrogen and essentially doubles the life of the catalyst when compared to known processes.

Thus, the Applicants' two-step process produces unexpected results with regard to at least the amount of hydrogen used and the life of the catalyst. These unexpected results are only achieved when the first and second steps are combined such that the materials used in the second step reaction have a very low non-aromatic compound content, as recited in the claims. It is undisputed that the

unexpected results represent an important improvement over processes that are conventionally known to those skilled in the art.

However, the Official Action states that the unexpected results are not persuasive because (1) the Applicants have allegedly not provided comparative data from a process in which a feed material with a high non-aromatic content were used in the second step, and (2) a showing of unexpected results allegedly must include a comparison of the closest prior art (*i.e.*, King).

With respect to reason number (1), the Examiner's attention is invited to Example 1 and Comparative Example 1 on pages 15-18 of the Specification (including Tables 1 and 2). These Examples represent real work actually performed by the inventors. Example 1 describes the process of the claimed invention in which the hydrogen consumption was determined to be 0.84 % by weight throughout the reaction of the second step, and the catalyst deactivation rate was found to be -0.04 weight percent/100 hours. Comparative Example 1 describes the results when the crude material, which has a non-aromatic compound component of 10 % by weight, was used as the starting material for the reaction of the second step. In other words, the first step distillation was omitted in the comparative example so that a material with a high non-aromatic compound content was used in the reaction of the second step. As described in Comparative Example 1, the hydrogen consumption was determined to be 1.14 % by weight throughout the reaction, and the catalyst deactivation rate was found to be -0.08 weight percent/100 hours. This data factually confirms the Applicants' unexpected results that coupling of the first and second steps reduces hydrogen use by over 25% and essentially doubles the life of the catalyst when compared to known processes in which a catalytic reaction (analogous to the second step of this invention) is not coupled with the first step of the invention.

With respect to reason number (2), the Applicants provide below a direct comparison between the claims of this application and the disclosure of King, which describes the catalytic

conversion of a C9 mixed alkyl aromatic feed having ethyl substituted aromatics to a product rich in toluene and xylene.

| Claim No. | Claims | King |
|-----------|--|--|
| 1 | a crude starting material comprising from 5 to 80wt% of benzene and other hydrocarbons | starting material at least about 20mol% of C9 aromatics (Claim 1). BZ/C9A=0.5(wt ratio), i.e. 33wt% of BZ (Table-4) |
| | and other non aromatics compounds in an amount of at least 10wt% | Non aromatics content in starting material is not disclosed. |
| | (A) lowering the content of said non aromatic compounds by distillation to produce a material having a non aromatic compound content of 1 wt% or less | Non aromatics content in C9 aromatics may be 0.74 mol%. It is not disclosed if or how non-aromatic content is lowered to 0.74 mol%. |
| | (B) reacting said material having a non aromatic compound content of 1 wt% or less | The material of benzene and C9 aromatics containing up to 0.74mol% of non aromatics is reacted. |
| | in the presence of hydrogen and a catalyst contains H-type synthetic | mordenite having a Si/Al atomic ratio of about 12 to 30. (Claim 1) |
| | and between about 0.02 to 2wt% rhenium | a catalyst consisting essentially of palladium on a dealminated mordenite (Claim 1) Other metals such as Pt, Rh, Ru, Ni, Re, etc are less effective (C.4 L. 32-33) |
| | at a pressure of from 0.1 to 100MPa | Suitably the reaction zone pressure is in the range of about 100 psig to 1000 psig. (P.9, L.24) |
| | and a temperature of from 200 to 650 degree C | Typically the feedstock is contacted with the catalyst in reaction zone at a temperature in the range of 340 degree C to about 460 degree C (P.9, L15) |
| 3 | The method as claimed in claim 1, wherein aromatic hydrocarbon conversion reaction is transalkylation reducing benzene content and C9 content to increasing the content of xylene and toluene in the | hydrocarbon product, which is enriched in toluene and/or xylene content relative to the starting material and reduced in toluene and C9 aromatic content relative to the starting material |
| 5 | The method as claimed in claim 1, wherein the material having a non aromatic compound content of 1wt% or less contains C9+ alkyl-aromatic hydrocarbons | In addition the aromatic feedstock can contain minor amounts of C10+ aromatics (P.8, L.9) |
| 6 | The method as claimed in claim 5, wherein benzen and C9+ aromatic hydrocarbon in the material having a non aromatic compound content of 1 wt% or less are reduced and C7 and C8 aromatic | hydrocarbon product, which is enriched in toluene and/or xylene content relative to the starting material and reduced in toluene and C9 aromatic content relative to the starting material |

| Claim No. | Claims | King |
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| 13 | The method defined in claim 1, wherein hydrogen is present in contact with said hydrogen, wherein said hydrogen has a flow rate of 0.1 and 20 mol/mol in terms of hydrogen /material. | by the presence of hydrogen which is added to the reactant feed to provide about 1 to about 6 moles of hydrogen per mole of hydrocarbon. (P.9, L27) |
| 17 | The method of claim 1, wherein the reaction pressure is between 0.5 and 60MPa and the reaction temperature is between 250 and 500 degree C. | Suitably the reaction zone pressure is in the range of about 100 psig to 1000 psig.(about 0.7 to 6.8MPa) (P.9, L.24). Typically the feedstock is contacted with the catalyst in reaction zone at a temperature in the range of 340 degree C to about 460 degree C (P.9, L15) |
| 18 | a crude starting material comprising from 5 to 80wt% of benzene and other hydrocarbons | starting material at least about 20mol% of C9 aromatics (Claim 1). BZ/C9A=0.5(wt ratio), i.e. 33wt% of BZ (Table-4) |
| | and other non aromatics compounds in an amount of at least 10wt% | Non aromatics content in starting material is not disclosed. |
| | (A) lowering the content of said non aromatic compounds by distillation to produce a material having a non aromatic compound content of 0.5wt% or less | Non aromatics content in C9 aromatics may be 0.74 mol% (Table-4). It is not disclosed if or how non aromatic content is lowered to 0.74 mol%. |
| | (B) reacting said material having a non aromatic compound content of 0.5wt% or less | The material of benzene and C9 aromatics containing up to 0.74mol% of non aromatics is reacted. |
| | in the presence of hydrogen and a catalyst containg H-type synthetic | mordenite having a Si/Al atomic ratio of about 12 to 30. (Claim 1) |
| | and between about 0.02 to 2wt% rhenium | a catalyst consisting essentially of palladium on a dealuminated mordenite (Claim 1) Other metals such as Pt, Rh, Ru, Ni, Re, etc are less effective (C.4 L. 32-33) |
| | at a pressure of from 0.1 to 100MPa | Suitably the reaction zone pressure is in the range of about 100 psig to 1000 psig. (P.9, L.24) |
| | and a temperature of from 200 to 650 degree C | Typically the feedstock is contacted with the catalyst in reaction zone at a temperature in the range of 340 degree C to about 460 degree C (P.9, L15) |
| 19 | The method as claimed in claim 18, wherein aromatic hydrocarbon conversion reaction is transalkylation reducing benzene content and C9 content to increasing the content of xylene and | hydrocarbon product, which is enriched in toluene and/or xylene content relative to the starting material and reduced in toluene and C9 aromatic content relative to the starting material |

| Claim No. | Claims | King |
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| 20 | The method as claimed in claim 18, wherein the material having a non aromatic compound content of 1 wt% or less contains C9+ alkyl-aromatic | In addition, the aromatic feedstock can contain minor amounts of C10+ aromatics (P.8, L.9) |
| 21 | The method as claimed in claim 5, wherein benzen and C9+ aromatic hydrocarbon in the material having a non aromatic compound content of 0.5wt% or less are reduced and C7 and C8 aromatic | hydrocarbon product, which is enriched in toluene and/or xylene content relative to the starting material and reduced in toluene and C9 aromatic content relative to the starting material |
| 22 | The method defined in claim 18, wherein hydrogen is present in contact with said hydrogen, wherein said hydrogen has a flow rate of 0.1 and 20 mol/mol in terms of hydrogen /material. | by the presence of hydrogen which is added to the reactant feed to provide about 1 to about 6moles of hydrogen per mole of hydrocarbon. (P.9, L27) |
| 23 | The method of claim 18, wherein the reaction pressure is between 0.5 and 60MPa and the reaction temperature is between 250 and 500 degree C. | Suitably the reaction zone pressure is in the range of about 100 psig to 1000 psig.(about 0.7 to 6.8MPa) (P.9, L.24). Typically the feedstock is contacted with the catalyst in reaction zone at a temperature in the range of 340 degree C to about 460 degree C (P.9, L15) |
| 24 | a crude starting material comprising from 5 to 80wt% of benzene and other hydrocarbons | starting material at least about 20mol% of C9 aromatics (Claim 1). BZ/C9A=0.5(wt ratio), i.e. 33wt% of BZ (Table-4) |
| 25 | and other non aromatics compounds in an amount of at least 10wt% | Non aromatics content in starting material is not disclosed. |
| | (A) lowering the content of said non aromatic compounds by distillation to produce a material having a non aromatic compound content of 0.1 wt% or less | Non aromatics content in C9 aromatics may be 0.74 mol%. It is not disclosed if or how non aromatic content is lowered to 0.74 mol%. |
| | (B) reacting said material having a non aromatic compound content of 0.1wt% or less | The material of benzene and C9 aromatics containing up to 0.74mol% of non aromatics is reacted. |
| | in the presence of hydrogen and a catalyst containg H-type synthetic | mordenite having a Si/Al atomic ratio of about 12 to 30. (Claim 1) |
| | and between about 0.02 to 2wt% rhenium | a catalyst consisting essentially of palladium on a dealuminated mordenite (Claim 1) Other metals such as Pt, Rh, Ru, Ni, Re, etc are less effective (C.4 L. 32-33) |
| | at a pressure of from 0.1 to 100MPa | Suitably the reaction zone pressure is in the range of about 100 psig to 1000 psig. (P.9, L.24) |

| Claim No. | Claims | King |
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| | and a temperature of from 200 to 650 degree C | Typically the feedstock is contacted with the catalyst in reaction zone at a temperature in the range of 340 degree C to about 460 degree C (P.9, L15) |
| | The method as claimed in claim 24, wherein aromatic hydrocarbon conversion reaction is transalkylation reducing benzene content and C9 content to increasing the content of xylene and | hydrocarbon product, which is enriched in toluene and/or xylene content relative to the starting material and reduced in toluene and C9 aromatic content relative to the starting material |
| 26 | The method as claimed in claim 18, wherein the material having a non aromatic compound content of 1 wt% or less contains C9+ alkyl-aromatic | In addition the aromatic feedstock can contain minor amounts of C10+ aromatics (P.8, L.9) |
| 27 | The method as claimed in claim 24, wherein benzen and C9+ aromatic hydrocarbon in the material having a non aromatic compound content of 0.1wt% or less are reduced and C7 and C8 aromatic | hydrocarbon product, which is enriched in toluene and/or xylene content relative to the starting material and reduced in toluene and C9 aromatic content relative to the starting material |
| 28 | The method defined in claim 24, wherein hydrogen is present in contact with said hydrogen, wherein said hydrogen has a flow rate of 0.1 and 20 mol/mol in terms of hydrogen /material. | by the presence of hydrogen which is added to the reactant feed to provide about 1 to about 6 moles of hydrogen per mole of hydrocarbon. (P.9, L27) |
| 29 | The method of claim 24, wherein the reaction pressure is between 0.5 and 60MPa and the reaction temperature is between 250 and 500 degree C. | Suitably the reaction zone pressure is in the range of about 100 psig to 1000 psig.(about 0.7 to 6.8MPa) (P.9, L.24). Typically the feedstock is contacted with the catalyst in reaction zone at a temperature in the range of 340 degree C to about 460 degree C (P.9, L15) |

As shown above in bold, independent claims 1, 18 and 24 of this application recite the step of lowering the non-aromatic content of the starting material by distillation to 1 %, 0.5 % and 0.1 % by weight, respectively. Assuming King is analogous to the second step of this invention, it still does not teach or suggest the step of distillation to provide a feed material with a low non-aromatic compound content, and certainly not a non-aromatic compound content within the claimed ranges. King does not even disclose the weight percentage of the non-aromatic content in its own feed material. Instead, King merely discloses that unidentified components (possibly non-aromatics)

comprise 0.74 mol % of a commercial C9 feedstock. Based on a fair reading of King, one skilled in the art would not be able to determine the weight percentage of the non-aromatic content of the feed material. (As set forth in the Official Action, the Examiner also cannot determine the weight percentage of the non-aromatic content in the King feed material.)

Because the non-aromatic compound content of the King feed material is not described or discussed, the skilled artisan would find no suggestion in King that the non-aromatic content of the feed material is important, let alone critical for achieving the Applicants' unexpected results. In other words, King cannot provide the requisite suggestion to render obvious the critical range of non-aromatic content in the starting material for the reaction of the second step because it provides no description of the non-aromatic content.

It is respectfully submitted that a comparison of the results achieved by the two-step process of this invention and King is not practical. King starts with a feedstock of unknown non-aromatic content, while the method of this invention starts with a crude material having at least 10 % by weight of non-aromatic compounds. Because the non-aromatic content of the King feedstock cannot be determined, it is not possible as a practical matter to measure the hydrogen consumption or catalyst life as a function of non-aromatic compound content in the feed material. Even if it were possible to make such a determination based on King, it is not the Applicants' burden to do so. Instead, if the rejection is based on the position that King would inherently achieve the results described by the Applicants, the PTO must show that King would necessarily do so.

Moreover, it is respectfully submitted that even if the King process included a feed material having a non-aromatic content within the claimed ranges, (which, it is worth noting again, cannot be determined), King still would not render the claimed invention obvious. King does not describe the process of how the material with a low non-aromatic content was made. As such, King includes no

teaching or suggestion that distillation was used to produce the feed material. Also, as explained above, King provides no suggestion that the non-aromatic content of the feed material is important. Therefore, King would provide no suggestion to one of skill in the art to lower the content of a crude starting material, and particularly not by distillation.

In addition, even if one skilled in the art were motivated by the disclosure of King to add a distillation step to convert a crude starting material to a material with a low aromatic content as the feed (which the skilled artisan would not be), there is still no suggestion to use a catalyst having 0.02 to 2 % by weight rhenium with the modified King process. In fact, King states at column 4, lines 31-36, that metals such as Pt, Rh, Ru, Ni and Re are less effective than palladium in the King process, thereby teaching away from using rhenium (Re) as the catalyst.

Thus, when taken alone, King differs sharply from the claimed subject matter. Because the non-aromatic content of the King feed material cannot be determined, it is not practical to provide a comparison of the results obtained by King with the unexpected results of this invention. In addition, King provides no suggestion that the non-aromatic compound content of the starting material is important, and, consequently, no suggestion to provide an initial distillation step to lower the non-aromatic content of a crude starting material. Further, even if King were modified to provide an initial distillation step, one skilled in the art would not have been motivated to modify the process of King to lower the non-aromatic content to the claimed ranges or to include a catalyst having 0.02 to 2 % by weight rhenium. In light of the substantial differences between the claimed invention and that described in King, and the clear lack of guidance provided by King to modify the process to arrive at the claimed method, one skilled in the art would have no motivation to attempt to modify the King process and, even if one did, no reasonable expectation of achieving the Applicants' unexpected results.

Combination of King and the "Admitted Art"

Because King lacks any teaching or suggestion to couple the catalytic conversion with a prior distillation step, the Official Action combines King with "admitted art" from the Applicants' own specification. The "admitted art" merely states that the benzene fraction derived from gasoline through distillation contains a large amount of non-aromatic compounds. The Official Action uses the "admitted art" as an alleged suggestion to combine King with a conventional distillation step to arrive at the claimed method, essentially by modifying King in two steps.

The first modification is based on the Applicants' own observation that the benzene fraction obtained from the distillation of gasoline contains a large amount of aromatic compounds. Based on this statement alone, the Official Action indicates that it would have been obvious to one of skill in the art to modify the King process by substituting the benzene fraction of the "admitted art" for King's commercial C9 feedstock as the starting material because it is expected that the use of any benzene mixture in the King process would yield similar results. (*See*, Official Action, page 5, second paragraph.)

Thus, the Official Action indicates that, according to the general knowledge available to one skilled in the art, a feedstock having a high non-aromatic content and a feedstock having a low aromatic content would work equally as well if provided directly to King's catalytic conversion process. The logic of the Official Action clearly implies that one skilled in the art would not expect the content of non-aromatic compounds in the feedstock of King to be important, or even relevant. Although the Applicants agree that one skilled in the art would not have appreciated the significance of the non-aromatic compound content in the feedstock of King, it is respectfully submitted that this lack of appreciation represents no motivation to modify King, as explained more fully below.

The second modification step set forth in the Official Action is based on the assumption that King has already been modified to use a benzene fraction from gasoline as the feedstock. According to the second modification, it would have allegedly been obvious to further modify the King process by removing the non-aromatic compounds from the benzene fraction by distillation because King requires only a low non-aromatic content in the feed material. Thus, the entirety of the rejection can be summarized as follows. One of skill in the art would be motivated to modify King by replacing the feed material having a low non-aromatic content with a feed material having a high non-aromatic content. The skilled artisan would then be subsequently motivated to remove the high non-aromatic content by distillation because the King process requires a feed with only a low non-aromatic content.

It is respectfully submitted that the alleged motivation to remove the high non-aromatic content of the substituted feedstock is inconsistent and incompatible with the alleged motivation to modify King in the first instance. Specifically, if one of skill in the art were to recognize that it were advantageous to use a feedstock with a low non-aromatic compound content (the alleged motivation for the second modification), one would not have modified King to use a feedstock with a high non-aromatic compound content in the first place. Put another way, if the reasoning set forth in the Official Action to justify the first modification is true, the skilled artisan would have no appreciation that a low non-aromatic content were important. As such, there could be no motivation to combine the King process with a distillation step to reduce the non-aromatic content of the feedstock.

Moreover, it is respectfully submitted that the mere lack of appreciation for the importance of the non-aromatic compound content in the King reference (the alleged motivation for the first modification) does not represent a suggestion or motivation to modify King by replacing the feedstock with a benzene fraction from gasoline. Instead, to establish obviousness based on a

combination of elements disclosed in the prior art or by modifying a single reference, there must be some motivation, suggestion or teaching of the desirability of making the specific combination that was made by the applicant. *In re Kotzab*, 55 USPQ2d 1313, 1316-1317 (Fed Cir 2000). The lack of appreciation that the non-aromatic compound content is important provides no suggestion that using a feedstock with a high non-aromatic content would be desirable. At best, the lack of appreciation would lead the skilled artisan to believe that the benzene fraction is no better than King's commercial feedstock. Therefore, it is respectfully submitted that, absent the Applicants' own teachings and any impermissible hindsight associated therewith, the "admitted art" would not motivate one skilled in the art to substitute the benzene fraction for the commercial feedstock of King.

For these reasons, it is respectfully submitted that there exists no suggestion or motivation in the references of record or in the general knowledge of one skilled in the art to modify King to arrive at the claimed invention.

Conclusion

For the reasons set forth above, it is respectfully requested that the rejections based on 35 U.S.C. §103 over King, either alone or in combination with the alleged admissions set forth in the specification, be reconsidered and withdrawn. It is believed that the application is now in condition for allowance, which action is respectfully solicited.

Respectfully submitted,



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